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CENTRAL INTELLIGENCE AGENCY

16 February 1951

INTELLIGENCE MEMORANDUM NO. 352

SUBJECT: Selected Strategic Minerals Industries

This memorandum describes important physical installations of the following minerals industries and areas of strategic importance to the United States:

1. The Chromite Industry in Southern Rhodesia
2. The Bauxite Industry in Surinam and Trinidad
3. The Tin Industry in Indonesia
4. The Tantalite and Columbite Industry in Nigeria
5. The Manganese Industry in the Gold Coast

Note: This report has not been coordinated with the intelligence organizations of the Departments of State, the Army, the Navy, and the Air Force. It contains information available to CIA as of 17 January 1951.

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1. The Chromite Industry in Southern Rhodesia.

a. Location.

The chromite deposits of Southern Rhodesia are found chiefly in two general areas: (1) the Selukwe and Victoria (or Mashaba) sections near the center of the colony and (2) narrow seams along the northern part of the Great Dyke, which extends in almost a straight north-northeast -- south-southwest line across Southern Rhodesia west of Salisbury and includes the Umvukwe Mountains. Within the areas mentioned the following districts are being exploited on a large scale; Selukwe (approximately 20 miles southeast of Gwelo), Lalapanzi (25 miles northeast of Selukwe), Makwiro (40 miles west-southwest of Salisbury), Darwendale (30 miles west-northwest of Salisbury), and the Umvukwe Mountains (40 miles north-northwest of Salisbury). All of the mines are near railways except those in the Umvukwe Mountains, the output of which must be hauled 20 to 40 miles by road to the nearest railroad.

b. Producers.

Most of the chromite production in Southern Rhodesia comes from the Selukwe area, one of the world's most important sources of metallurgical-grade ore because of the high chromic oxide content and large reserves. The second district of importance is the Great Dyke, which extends for some 300 miles, where the chromite is found in bands or layers which, although thin, represent a very large reserve of metallurgical and chemical-grade ores.

The leading producers are the Rhodesian Chrome Mines, Ltd., in the Selukwe area, and the African Chrome Mines, Ltd., in the Great Dyke-Darwendale district. Other important producers are the Rhodesian General Asbestos Corporation, in the Great Dyke and Selukwe area~~s~~; the Rhodesian Vanadium Corporation, in the Great Dyke area; the Neil Chrome Mines, Ltd., near Lydiate; and the Cambrai Mine Company, near Concession, east of the Great Dyke area. Still another organization, the Chrome Producers (Rhodesia), Ltd., is a marketing outlet for several small mining operators.

c. Methods.

Methods of mining chromite in Southern Rhodesia vary. In the Selukwe area the first chromite deposits were exploited by quarrying. Later, when the depth became too great for quarrying, top slicing was adopted where the wall rocks were soft enough. As greater depths were reached, the wall rocks became firmer and sublevel stoping was introduced. In the past the Great Dyke seams were mined chiefly by open-cut workings. In the underground mines the resuing method is commonly employed because of the narrowness of the seams.

At a large number of mines the ore is sold without dressing except for selection in mining, sorting by hand, and cobbing. The grade of friable ores is at times raised by crushing, followed by gravity concentration to eliminate silica and other associated minerals not chemically combined with the chromite.

d. Neil Chrome Mines, Ltd.

Exact information is available for only one mine -- the Neil Chrome Mines, Ltd., located on the eastern side of the Great Dyke, 6 miles northwest of Lydiate, which is on the main line of the Rhodesian Railways, Ltd. It also has good road connections with Salisbury, about 35 miles east of Lydiate. The mining property is located on both sides of the Hunyani River, with the greater frontage on the north side. Production has been almost entirely from the north side, as the deposits on the south side are covered by an overburden of considerable depth. In this area, hand methods are used in exploiting open-cut mines. The mining is done by natives working under contract and with a minimum amount of supervision.

The milling plant includes a hammer mill and two James tables. The hammer mill and one James table were installed in 1938, and the other table was added in 1946, bringing the capacity of the plant up to 1,000 tons of washed concentrates per month. Large pieces of ore are broken by hand at the mill before being

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fed to the hammer mill. Since the ore is mined clean, milling consists essentially of washing rather than concentration. The launders of the James tables are equipped with eight mesh screens, and these oversize screenings are stored for use in crushing and tabling during slack periods. After milling, the ore is trucked 6 miles from the mill to Lydiate. The Neil Chrome Mines, Ltd., has electric power (550 volts) available at the mill, and the power line could be extended to serve the mine. An abundant supply of water from the Hunyani River is available for milling purposes. When underground mining is undertaken, it is possible that the amount of underground water encountered might make pumping necessary.

e. Transportation.

All Southern Rhodesian chrome ore is shipped by rail and exported through the port of Beira in the Portuguese colony of Mozambique. The ore must be carried distances varying from 400 to 600 miles, depending on the location of the mining area. The ore moves over the Rhodesian Railways, Ltd., to the Rhodesian border, then over the Beira Railway in Mozambique to Beira harbor. The railways are owned by the respective governments, but they form a continuous single-track line of 3-foot--6-inch gauge. Telegraph and telephone are used in dispatching trains. Because of a shortage of rolling stock, the railway has been a bottleneck in the shipping of chrome ore; consequently, large stockpiles have accumulated at some of the larger mines.

There are on the Beira Railway (as of 31 December 1948) 49 bridges and 633 culverts. Between Beira and Vila Machado are 41 bridges and 107 culverts; the largest of the bridges has five spans and approaches consisting of eight viaducts across the Pungwe River flats, a distance of 7,659 feet. Between Vila Machado and Macequece are eight bridges and 526 culverts. There are no tunnels on the Beira Railway. Eleven watering stations are located along the route.

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In the section about 60 miles long between Beira and Vila Machado, grades are slight and relatively large quantities of freight per train can be hauled. Between Vila Machado and Vila Pery the land becomes higher, and the grade increases rapidly in an almost continuous series of sharp curves, some of which have a radius of only 80 meters, or about 250 feet. Between Vila Pery and Macequece the grades are gentler, but they increase again between Macequece and Umtali, where the railroad climbs rapidly in a series of sharp curves.

In the section of the Rhodesian Railway from Umtali to Salisbury, the line climbs steadily from an elevation of 3,551 feet at Umtali to 5,446 feet at Marandellas and then drops to 4,825 feet at Salisbury. There are 12 bridges, each over 40 feet in length, between Umtali and Salisbury, and 10 bridges between Salisbury and Gwelo.

In 1950 a new railway yard with 10 sidings was being built at Machipanda (a Portuguese customs station 6 miles below Umtali). This will provide additional storage space for approximately 10,000 tons of freight until it can be moved to Umtali.

Along the line of the Rhodesian Railways, Ltd., marshaling yards and repair facilities are located at Bulawayo, Salisbury, Livingstone, Broken Hill, Gwelo, and Umtali. All are key points, because this railway system is the main route for transportation in both Northern and Southern Rhodesia as well as the outlet for chrome ore. Three marshaling yards -- at Salisbury, Gwelo, and Umtali -- are directly connected with the shipment of chrome ore, since ore trains must pass through these points en route to Beira.

f. Port of Beira.

Beira, located at the mouth of the Pungwe and Busi Rivers, is the chief export port for Southern Rhodesia and other countries of East Africa. Practically all the chrome ore, copper from

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Northern Rhodesia, and miscellaneous products from other areas of East Africa are exported through Beira. The total of these items plus imports is greater than the port can readily handle, resulting in congestion at the port and need for storage space, which is further accentuated by the fact that the railways serving Beira are not capable of distributing imports as rapidly as they enter the port.

Plans are now under way for improving conditions at the port. A mineral wharf is to be constructed, additional storage space is to be provided, and more equipment to facilitate the handling of products, especially ores, is to be installed.

The port is served by electric power from a municipal power station and a second station located near marshaling yards in the vicinity of the Pungwe and Chiveve wharves.

Because of the exposed position of Beira, a sea wall, the Chiveve Embankment, has been built to prevent the encroachment of the sea.

The facilities of the port at present include a deep-water 2,670-foot pier capable of handling five sea-going ships drawing up to 30 feet, mooring buoys in the anchorage for six sea-going ships, a lighterage pier 1,464 feet long, and transit sheds and open space for the storage of minerals. The one berth available for the unloading of oil tankers is connected by pipelines with installations of the oil companies.

Twelve miles off the coast at the mouth of the river, there is a pilot light, and at Macuti, on the shore 4 miles from Beira, is a lighthouse with a radius of 18 miles. The channel is indicated by luminous buoys, and ships with a draft of 30 feet can enter at high tide. The lowest water on Portella bar is 11 feet 8 inches, but the new President Carmona channel has been dredged to a depth of 17 feet.

Approved For Release 1999/09/21 : CIA-RDP79T00935A000100120001-0

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2. The Bauxite Industry in Surinam and Trinidad.

a. General.

Bauxite mining and its associated activities are being carried on in three general areas in Surinam. Two of these areas, Paranam and Moengo, are being worked by the Surinam Bauxite Company, a subsidiary of the Aluminum Company of America. The third, Onverdacht-Smalkalden, is a concession being worked by the N.V. Billiton Company, a Dutch concern.

Virtually all of the bauxite mined in the three areas is shipped to North American ports either directly or by way of Trinidad. Transshipment terminals are maintained at Trinidad by both the Alcoa Steamship Company, Inc. (US), and the Aluminum Corporation of Canada. The former receives ore from Surinam for transshipment at its terminal, whereas the latter handles ore from mines in British Guiana.

b. Paranam Area.

(1) Location of Installations.

(a) Paranam, on the west bank of the Surinam River 20 miles upstream from Paramaribo, is the site of the processing installations and loading station;

(b) Topibo Hill, 4.5 miles west of Paranam, is the site of a mine that is nearly worked out;

(c) Onoribo, ~~2½~~ 2.2 miles northwest of Topibo Hill, is the mine site now being most actively worked;

(d) Rorac, on the east side of the Surinam River 5 miles north of Paranam, is the site of a new concession in the process of being developed.

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(2) Description of Installations.

(a) Mining Installations.

All of these mines are worked by open-pit methods, using highly mechanized equipment.

At the Onoribo mine, which is now supplying the bulk of the ore for the processing plant at Paranam, six 1.5-cubic-yard and two 1-cubic-yard diesel shovels are in operation. The reserves at this deposit appear to be roughly 1.5 million tons, or sufficient to last until mid-1952 at the present rate of operation.

The Topibo Hill site is divided into two concessions, both of which are nearly worked out. It was anticipated that operations at the site would be abandoned by the end of 1950.

The best remaining untouched reserves in the area are at Rorac. Actual mining of ore at the site is not expected to begin until 1952. The ore will be mined, crushed, and partially washed at Rorac and then moved by barge to Paranam for drying and shipment. Reserves are believed to be extensive enough to provide for from 5 to 7 years of operation at the mine.

(b) Processing Installations.

At Paranam, installations are provided for crushing, washing, screening, drying, storing, and loading bauxite. The ore is crushed in hammer mills, washed and screened, and conveyed to rotary kilns -- two drying kilns (combined capacity, 180 to 190 tons per hour) and one calcining kiln (capacity, 10 tons per hour). The bauxite from the two drying kilns is conveyed to a 36,000-ton storage shed of concrete construction, whereas the calcined bauxite passes through a cooling system and then to special steel storage bins. Both the storage shed and the bins are connected with loading conveyers at the dock. Two conveyers on the 200-foot wooden dock can load one ship at a time in 12 hours or less.

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Power from the installations is supplied by a company-owned diesel electric plant located on the grounds.

Water for industrial use is pumped directly from the Surinam River. Water for sanitary use is supplied by two wells and is stored in a 100,000-gallon tank built on a 150-foot tower at the plant site.

Four steel tanks are provided for fuel oil storage, and two for diesel oil storage.

The mills at Paranam are of steel and concrete construction.

(c) Transportation and Communication.

A fleet of nine 14-ton Euclid trucks transports ore from the Onoribo mine over a bauxite-surfaced road to the Topibo Hill railway terminal, a distance of 2.2 miles. From this terminal ore is sent to Paranam over a 4.5-mile, single-track, 36-inch-gauge company-owned railway. Diesel locomotives draw trains of 16 cars of 20 tons each. A road parallels the railroad from Topibo Hill to Paranam but is not used for ore transport.

c. Moengo Area.

(1) Location of Installations.

(a) Moengo, situated on the east bank of the Cottica River, 104 miles by river from Paramaribo, is the site of the processing installations and loading station.

(b) Rikanau Hill, 8 miles due east of Moengo, is the site of the bauxite mine.

(2) Description of Installations.

(a) Mining Installations.

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The open-pit method of mining is employed at Rakanau Hill. Overburden is stripped by bulldozers, and the ore is then dug, without blasting, by electric shovels. Dump trucks carry the bauxite from the pit to ore cars at the railway terminus.

(b) Processing Installations.

The mills are of steel and concrete construction. Ore cars bringing bauxite to the mills dump their load directly into an open hopper. From the hopper the ore is carried by belt feeder to a new underground hammer mill having a capacity of from 400 to 500 tons per hour. Since the ore requires no washing, it is then moved by conveyors to three rotary drying kilns having a combined maximum capacity of 150 tons per hour or to an open storage area. The ore moves next to temporary storage, from which it is loaded aboard vessels via a single loading chute at a rate of 600 tons per hour.

The storage building has a capacity of 40,000 tons and is of concrete construction with corrugated iron roofing.

The loading dock at Moengo runs parallel to the river bank for 300 feet. Half the length of the dock has recently been reconstructed, using sheet steel piling filled with earth; the other half is of wood construction. Railway facilities run the entire length of the dock.

Power and light at the plant are supplied by a company-owned diesel electric plant.

Water for sanitary use is supplied by two 30-foot wells and is stored in a 100,000-gallon tank built on a 100-foot tower. The company has a filtration plant which, in case of emergency, will allow river water to be used with safety.

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Four 5,000-barrel storage tanks are provided for fuel oil, and two 2,500-barrel tanks for diesel oil storage.

(c) Transportation and Communication.

Bauxite ore is transported from the mine at Rikanau Hill to the processing plant at Moengo by means of sixty 21-ton side-dump cars, which are pulled by diesel locomotives over an 8-mile 36-inch-gauge railroad. A road parallels the railroad but is not suitable for trucking -- it is narrow and has one bridge inadequate to support heavy traffic.

With the exception of a single gravel road from French Guiana, the only means of transportation to Moengo is by river. The river route follows the Surinam River to the mouth of the Commewijne, the Commewijne River for 17 miles to the mouth of the Cottica, and the Cottica River for 79 miles to Moengo. In order that ore ships may safely pass a sand bar near the mouth of the Commewijne River, their draft is at present limited to a maximum of 18½ feet. The upper part of the Cottica River is narrow, and for the last 7 miles of passage the larger ore boats are towed upstream backwards by tug. Although ships up to 447 feet in length now make the trip to Moengo, tugs are employed on the Cottica River to assist them around sharp bends.

Communication between Moengo and Paramaribo is by radio.

d. <u>Onverdacht-Smalkalden Area.</u>

(1) <u>Location of Installations.</u>

(a) Smalkalden, situated on the west bank of the Surinam River approximately one-half mile north of Paranam, is the site of the drying plant and loading station of the Billiton Company.

(b) Onverdacht, 4 miles west of Smalkalden, is the site of the mine and crushing mill.

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(2) Description of Installations.

(a) Mining Installations.

Bauxite is extracted by the open-pit method, using diesel drag-lines and bulldozers. The ore beds average 10 feet in thickness, and the reserves are large, but figures on actual working reserves are not available.

(b) Processing Installations.

Ore is crushed at the mill at Onverdacht in the immediate vicinity of the mine and then transported to Smalkalden for drying. The combined crushing, drying, and loading plants of the company are about the same size as those at Paranam, and the processing methods are the same. Both calcining and drying kilns are used, but figures on kiln capacity are not available at present. One ship at a time can be loaded at the dock, using two loading belts having a combined capacity of about 500 tons per hour.

(c) Transportation and Communication.

Ore is transported the short distance from the mining pit to the crushing mill at Onverdacht by truck. From the crushing mill ore is moved to Smalkalden both by trains over a double-track 24-inch-gauge railroad, and by truck over a road that parallels the railroad and is maintained in usable condition in all seasons.

Bauxite is shipped from Smalkalden in chartered vessels. The major portion of the ore is transshipped at the Point Tembladora transshipment terminal in Trinidad.

Smalkalden is linked with Paramaribo by telephone.

e. Point Tembladora Transshipment Terminal (Alcoa).

The primary purpose of this transshipment terminal in Trinidad is to transfer bauxite arriving from Surinam in small

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ships to larger northbound ships, and to fill up (or top) the north-bound ships that arrive from the mines with part cargo.

(1) Location of Terminal.

The terminal site is at Point Tembladora (latitude $10^{\circ}40'49''$N-$61^{\circ}35'53''$W), seven miles west of Port of Spain. The west boundary of the plant site is coincident with the east boundary of the United States Naval Base leased area.

(2) Description of Installations.

(a) Dock Facilities.

The terminal has one 680-foot concrete dock constructed on steel piling. The working length of the dock is 450 feet, with one side used for loading and the other for unloading ore.

Two unloading towers equipped with 5-ton clamshell buckets can together discharge one large vessel or two smaller ones at a rate of 600 tons per hour. The towers operate on a 30-foot-gauge track and are capable of traveling 480 feet along the pier. Direct-current electric tractors are used for trimming ships' holds during the unloading process.

The loading equipment of the company consists of one traveling loading tower having a capacity of 2,000 tons per hour. The tower receives ore from a conveyer belt and transfers it by chute to the ship's hold.

(b) Storage Facilities.

Bauxite is conveyed either directly from the unloading to the loading tower or to the fifteen 5,000-ton storage tanks located on the bulkhead area northeast of the dock. The tanks are constructed of field-welded steel plates and rest on steel-pile and concrete foundations.

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(c) Power Installations.

The power installations provided at the terminal consist of two diesel generators and an AC-DC converter plant. The generators are capable of producing 1,000 kilo-volt-amperes each, or 800 kilowatts at 80-percent power factor. Normally these installations supply power for the unloading towers only, and the power for the conveyers, loading towers, and other plant facilities is purchased from the Port of Spain municipal power station. It is reported (early 1951) that the municipal generator has been broken down for several months and that the company power plant has been providing all the power.

(d) Water Supply.

Water is obtained from the local public water supply system and is stored in an 150,000-gallon steel tank located on a hillside immediately north of the terminal. The water is used both for sanitary purposes and for supplying ships.

(e) Fuel Storage.

In the vicinity of the water storage tank are two 25,000-barrel steel storage tanks for Bunker C oil, one 10,000-barrel tank for heavy diesel oil, and one 10,000-barrel tank for light diesel oil. The Bunker C oil and the heavy diesel oil are used for bunkering and fueling ore vessels, whereas the light diesel oil is used in operating the plant's diesel generators.

f. Chaguaramas Bay Transshipment Terminal.

The bauxite transshipment terminal at Chaguaramas Bay in Trinidad is owned by the Aluminum Corporation of Canada and receives its ore from mines in British Guiana.

(1) Location of Terminal.

The terminal is located at the east end of Chaguaramas Bay (latitude $10^{\circ}40'30''$N-longitude $61^{\circ}38'03''$W), approximately 3 miles west of Point Tembladora along the main western road. On the landward sides the installation is surrounded by property under lease to the US Navy.

(2) Description of Installations.

(a) Dock Facilities.

The terminal has a 900-foot wharf constructed of interlocking sheet piling filled with rock. The wharf, 200 feet in width, parallels the shore line and thus has but one working side.

The terminal is equipped with two traveling unloading towers, each handling grab buckets of 4-ton capacity. The towers discharge one vessel at a time at an average rate (including trimming) of 450 tons per hour.

One traveling loading tower, having a capacity of 1,000 tons per hour, handles the loading operations of the terminal. Only one vessel, therefore, may be loaded at a time. Discharging and loading operations may, however, be carried on simultaneously.

(b) Storage Facilities.

One large steel-and-concrete building is provided for bauxite storage. The building, measuring 600 feet by 200 feet by 80 feet, has a capacity of 170,000 tons and is located just east of the wharf. Space for 250,000 tons of open storage is available near the south end of the storage building.

(c) Conveyer System.

Six main conveyer belts capable of carrying 1,000 tons of ore per hour handle the movement of ore at the terminal -- a discharging belt, a loading belt, and four belts for conveying ore to and from the storage building.

(d) Power Provisions.

The power necessary for operating the loading and unloading towers, the conveyers, and other installations is purchased from the Port of Spain municipal power station. It is reported that the municipal generator at the Port of Spain has been broken down for months. It is presumed that the power to operate the Chaguaramas Bay Terminal is provided by the Billiton Company.

g. Bauxite Shipping.

Sand bars at the mouths of the Surinam and Commewijne rivers can at present be safely passed only by vessels drawing no more than 18½ feet. Thus large ore vessels plying these rivers find it impossible to take aboard full cargoes at the mines. As a result, two methods are generally employed in shipping bauxite from the mining areas in Surinam: (1) small vessels shuttle between the mining areas and Trinidad, unloading their ore at the Point Tembladora transshipment terminal for immediate transshipment or storage, and (2) large vessels take on a partial cargo at the mine docks and then stop at Point Tembladora for topping before proceeding to US ports. A few vessels operate directly from the mining districts to the US.

Bauxite from the Moengo and Paranam mines is transported by the Alcoa Steamship Company, Inc. (US). In addition to operating its own fleet, the company charters a varying number of vessels on a time basis.

On the shuttle run between Moengo and Point Tembladora the company operates two converted LST's that are tug-towed, two time-chartered LST's that are self-propelled, two British-constructed 7,000-ton vessels, and several small time-chartered vessels. A few small time-chartered vessels are also operated between Paranam and Point Tembladora.

The following ships are operated by the Alcoa Steamship Company from the mining districts through to the US, stopping at Point Tembladora for topping:

3 Victory-type passenger-freighters	-- Alcoa-owned
3 C2 cargo ships	-- Alcoa-owned
10 Cl cargo ships	-- Alcoa-owned
3 Norwegian liberty ships	-- 40% Alcoa-owned
7 Norwegian liberty ships	-- chartered

Very little information regarding shipment of ore from the Billiton Company mine was available at the time this report was prepared. It is believed that the ore is transported in chartered vessels. A major proportion of the Billiton ore is known to be transshipped at Point Tembladora.

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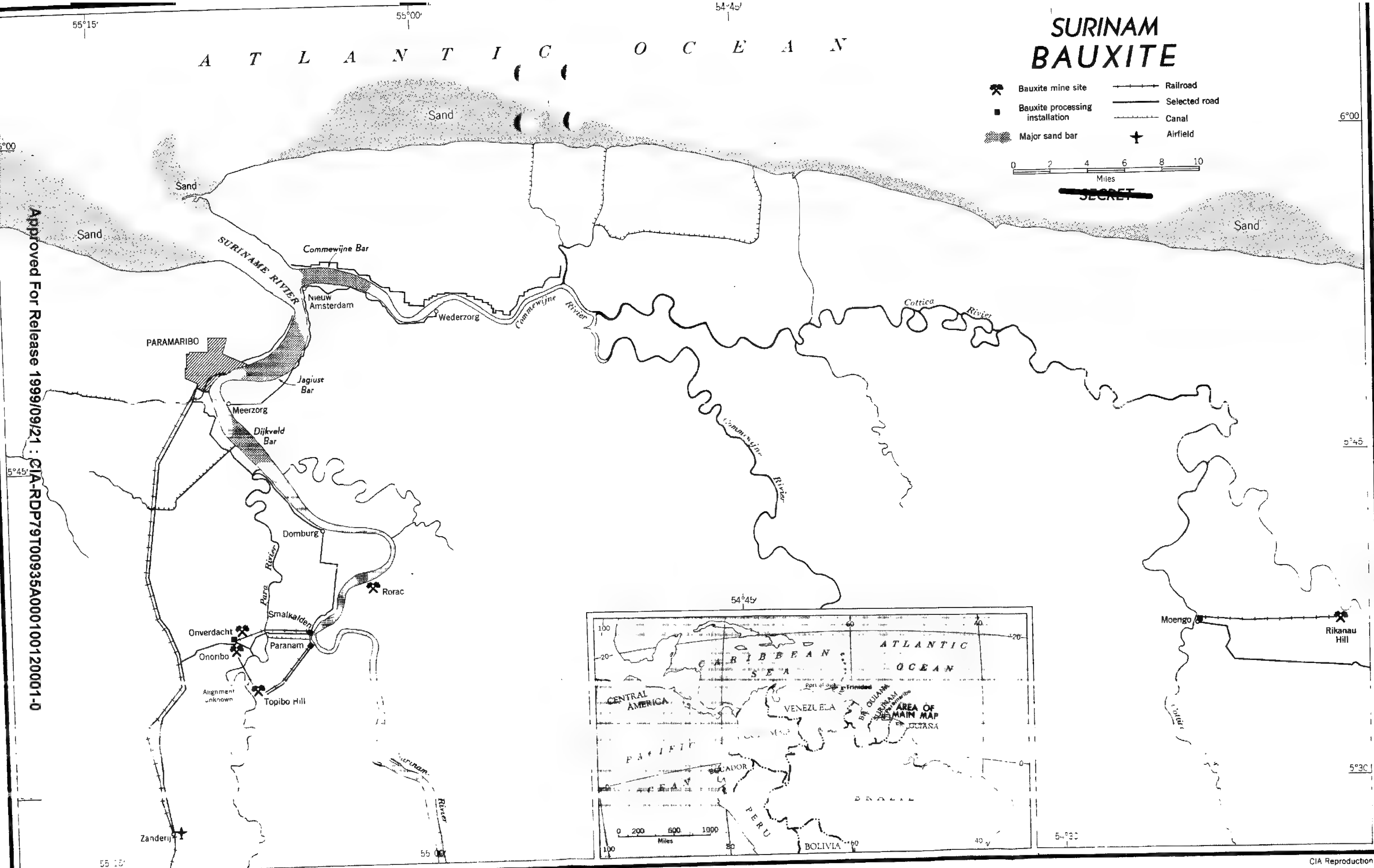

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3. The Tin Industry in Indonesia.

a. Importance of Indonesian Tin Production to the US.

Indonesia supplies the major portion of the high-grade tin concentrates imported for the use of the Texas City smelter, where they are mixed with the much lower grade of concentrates imported from Bolivia in order to obtain a higher-grade product than could be secured from Bolivian concentrates alone.

b. General Operating and Production Facilities.

The developed tin deposits of Indonesia are located on the islands of Bangka, Billiton, and Singkep. The deposits on Bangka are owned by the Indonesian Government but are now operated by the Billiton Company under a five-year contract signed in 1948. Since this company has its own deposits on Billiton and Singkep, it now controls the entire tin industry.

In spite of the retarding effect of political disturbances and labor troubles on rehabilitation, the production from the islands has reached the normal prewar level of about 30,000 long tons. During 1949, tin production from dredges amounted to 66 percent of the total, from hydraulic mines 31 percent, and from mines worked on the tribute system and other small operations 3 percent.

Of greatest importance are the dredges. The capacity of dredges and sizes of buckets used vary according to the size of the ore reserve in a particular locality. The better equipped dredges have their own concentrating plants on board, consisting of trommel screens to eliminate the coarsest material and jigs and tables to produce clean concentrates containing about 75 percent tin. The older and smaller dredges produce a medium-grade product containing 20 to 40 percent tin, which is later upgraded in a concentrating plant.

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Of the eight new dredges with 14-cubic-foot buckets that arrived at the islands in late 1947 and early 1948, four are operating at Bangka, two at Billiton, and two at Singkep. These large dredges are, in effect, floating concentrating plants that operate in sea areas or near the sea. Each is said to be capable of recovering well over the equivalent of 1,000 tons of metallic tin a year. Each dredge is also a self-contained power house and pumping station, electric power being generated by super-charged diesel engines directly coupled to generators. The dredge is fitted with an elaborate system of automatic relays and safety devices, as well as with indicating and recording apparatus to facilitate rapid and centralized control.

Second to the dredges in importance are the hydraulic mines. Here electrically driven pumps for water and gravel are mounted on pontoons that can be floated from one part of a pit to another. The ore-bearing deposits are pumped by gravel-pumps to sluices, where the tin mineral (cassiterite) is recovered and cleaned. The resulting product, containing 20 to 30 percent tin, is then transported to a concentrating plant to be brought up to standard grade. Other earth-moving equipment, such as bull-dozers, draglines, and excavators, is used on a small scale, chiefly for preparing mine roads, constructing small dikes, and digging fresh-water canals.

c. Bangka.

The principal tin-producing area of Bangka is in the northern half of the island, and the most important mining center is in the Sungailiat tin fields in the northeast. The head office of the mining activities is in Pangkalpinang.

Although the rehabilitation of the Bangka tin operations did not get under way until several months after that of Billiton, production today represents about 60 percent of the total tin production from all three islands. This is partly due to the fact

that half of the new dredges with 14-cubic-foot buckets are at Bangka. At present, 11 dredges are operating at Bangka -- six with 9-cubic-foot buckets, four with 14-cubic-foot buckets, and one with 15-cubic-foot buckets. Another large dredge caught fire last July and is still out of commission. The accompanying map indicates only four large dredges on Bangka; from available data it is not possible to determine which of the remaining dredges shown is the fifth large dredge.

Electric power is used for the dredges, as well as for gravel-pumps and for stripping overburden in open-cut mines by counterbalanced monitors. The main power plant is located at the port of Mantong, near Belinju* in the northern part of Bangka. Power is generated by a steam turbine; coal for the boilers is brought by steamers from Sumatra and lightered into the port.

The biggest repair shop on the island is located at Sungailiat.

d. Billiton.

The principal tin-producing districts on Billiton are located in the eastern and northern parts of the island. The town of Manggar is the main center of mining activity.

At Billiton, there are 14 dredges in operation, five with 14-cubic-foot buckets, eight with 7-cubic-foot buckets, and one with 5-cubic-foot buckets. Two of the five large dredges are of the postwar type. These dredges are equipped with three diesel generator sets of 600 to 700 horsepower each, one of which acts as a stand-by. Although all dredges are electrically driven, the two 7-cubic-foot dredges used in Tandjungpandan district generate the necessary electric power by wood-fired steam engines on board, whereas the other dredges are fed from the Manggar power station.

* Or Blinju.

The main power station is actually situated at Tandjung Samak, a small port near Manggar. Diesel oil for this power station is delivered to storage tanks by means of 4,000-ton oil tankers, which can moor directly at the pier at Tandjung Samak. Except for the oil discharge pier at Manggar, there is no other place on the island where steamers of any size can moor and discharge directly onto the shore. A second small power station, located at Tandjungpandan, supplies electric current for lighting houses.

The main repair shop also is near the town of Manggar, but there are four small repair shops and a great number of auxiliary shops distributed throughout the island. The four smaller repair shops are located near Gantung, at Tandjungpandan, east of Tandjungpandan, and at Klappa Kampit. The last is situated at a deep mine flooded during the war and not now in operation.

e. Singkep.

The more important tin-producing areas are located in the eastern part of the island. Kotadabok,* the principal village of the island and the site of the only electric power station and the repair shop, is in the same area.

Two large offshore dredges with 14-cubic-foot buckets and one inland dredge with 9-cubic-foot buckets operate near Kotadabok; another large dredge is operating inland near the north coast. A number of small mines consisting of one or more gravel-pumps are also in operation.

Some diesel oil is stored on the island to supply the diesel engines of the electric power station.

The waters around the island of Singkep are shallow, and even small steamers cannot moor near enough to discharge or take on cargo directly. Motor launches and lighters ply between the ship and shore.

* Or Dabo.

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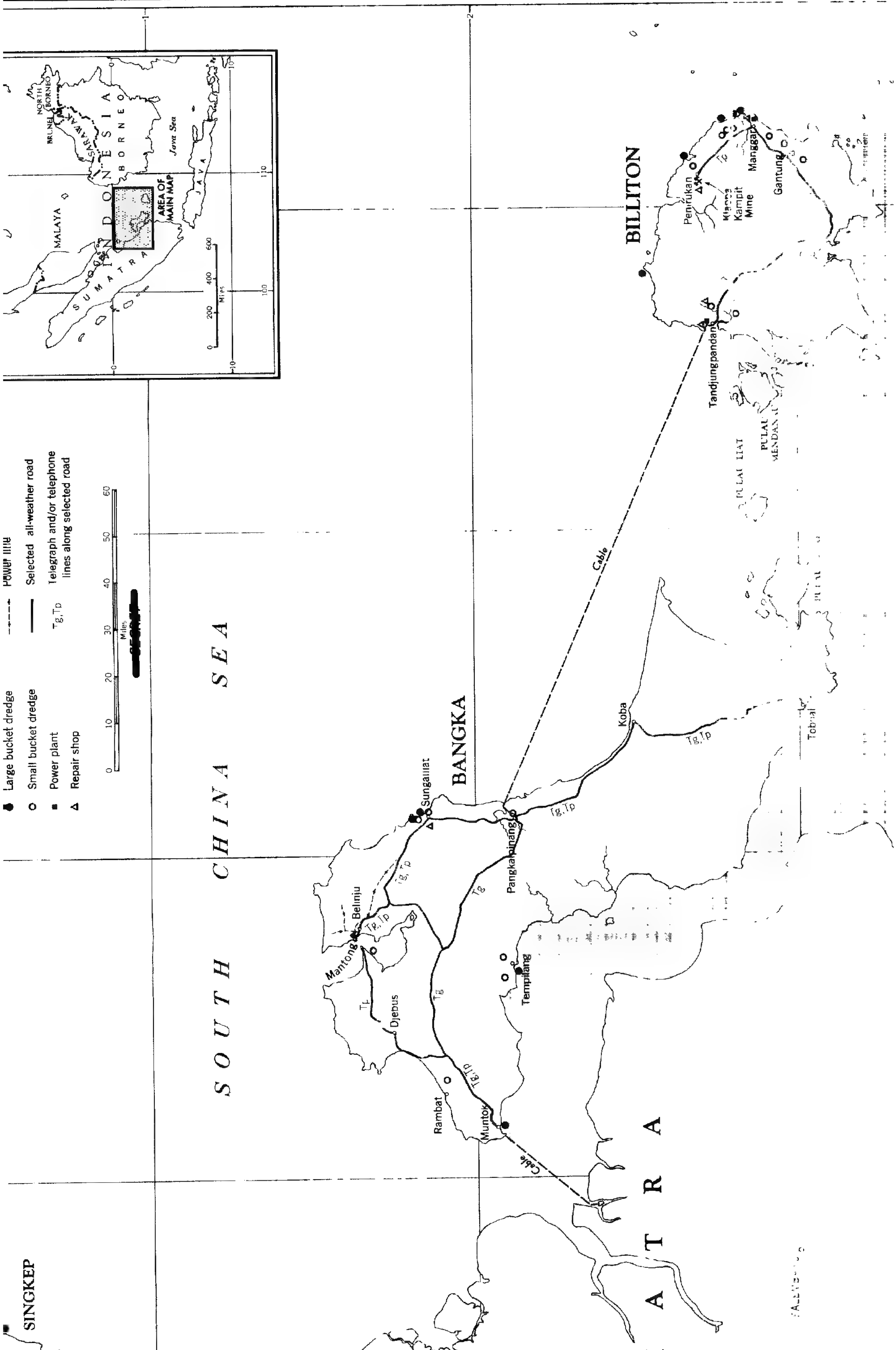

Large bucket dredge
Small bucket dredge
Power plant
Repair shop
Power line
Selected all-weather road
Tg, Tp Telegraph and/or telephone lines along selected road
0 10 20 30 40 50 60
Miles
[redacted]
SOUTH CHINA SEA
BANGKA
BILLITON
SINGKEP
SUMATRA
Sungailiat
Belinju
Mantong
Djebus
Rambat
Muntok
Tempilang
Pangkalpinang
Koba
Toboali
Tandjungpandan
Penrukan
Kampit Mine
Manggar
Gantung
Cable
Tg, Tp
Tg
Tp
PULAU MENDANAU
MALAYA
NORTH BORNEO
BRUNEI
SARAWAK
INDONESIA
BORNEO
Java Sea
JAVA
SUMATRA
AREA OF MAIN MAP
0 200 400 600
Miles

4. The Tantalite and Columbite Industry in Nigeria.

a. General.

The tantalite and columbite of Nigeria are associated with tin and are mined from some 35 scattered deposits. The deposits are all open placers with about 20 feet of overburden. Introduction of Kipp Kelly air float separators (for concentrating ore) has rendered possible production from areas of lower grade ore which previously were not regarded as being economic to utilize. Water is very scarce and limits the use of wet methods of concentration. Although the country is open and prospecting is not difficult, a material increase in production can hardly be effected because of the limitations. Mining methods are simple and fairly primitive, and the concentration is accomplished by small scattered units.

The production of tantalite in Nigeria centers in the Egbe area in Kabba Province. Formerly, tantalite was derived from tin tailings, but it is currently being extracted from alluvial deposits. Nigerian columbite comes chiefly from the Jos area of Plateau and Bauchi Provinces as a by-product of tin operations. Approximately 1 ton of columbite is produced for each 7 tons of tin. Scattered pockets of pegmatite containing columbite and tantalite are found in several of the northern provinces.

The two largest producers of tantalite are the Hamber and Paravicini interests operating in the Egbe area, but six companies near Wamba, Plateau Province, produce smaller quantities. The total Nigerian production of tantalite through 1947 amounted to slightly more than 20 long tons. About 1.30 long tons were produced in 1946 and 2 long tons in 1949. Known reserves of tantalite concentrates approximate 173 long tons.

The major producers of columbite are the Jantar Nigeria Company, Amalgamated Tin Mines of Nigeria, and the Bisichi Tin Company, but several other concerns also produce significant quantities. In 1947 Nigerian production was 1,286 long tons, or

95 percent of the world's industrial needs. Production of columbite averages 1,000 long tons per year but was considerably higher during World War II. It is estimated that in 1950, 1,069 tons of columbite concentrates were produced, of which 418 tons were destined to the UK and 651 tons to the US. The amount produced is closely associated with the relative prices of columbite and tin. High-quality reserves are estimated at slightly over 9,000 long tons and are located chiefly in the vicinity of Jos. The US company which purchases concentrates lists 32 producing companies with which it deals, of which only four produce over 100 tons of concentrates per year (1950 figures); only one produces between 50 and 100 tons per year, six produce between 10 and 50 tons per year, and the rest produce less than 10 tons per year each. The concentrates have comparatively small bulk and a high value. Individual shipments are therefore small.

b. Electric Power.

Mining operations in the Jos area are dependent upon electricity supplied by three hydroelectric plants of the Nigerian Electricity Supply Corporation, owned by Amalgamated Tin. Dams supplying water for these plants are located at Kurra Falls, 29 miles southeast of Bukuru; at Tenti, 27 miles south of Bukuru; and at Kwall Falls, 14 miles east of Jos. The Kurra Dam, the largest of the three, and the Tenti Dam are constructed of laterite with wooden gates and concrete spillways.

c. Mining Equipment.

Equipment in use in mining operations includes bulldozers, hydraulic elevators, bucket dredges, draglines, scrapers, pumps, air compressors, and power shovels. Specialized equipment is used in dressing plants near the mine sites for tabling, floatation, and magnetic separation. Mine operation depends upon a supply of water which is usually obtained from a series of small dams nearby.

d. Railroads.

The government-owned Nigerian Railway has two main lines. A northeast-southwest line runs from Apapa to N'guru via Kaduna, Zaria, and Kano. The second line runs north from Port Harcourt and joins the other line at Kaduna Junction. A cutoff at Kafanchan serves the Jos area. Unlike tin, which is shipped to Port Harcourt, tantalite and most of the columbite are transported to Apapa (Port of Lagos), which is a port of call for a larger number of American ships. The ore is shipped via the 3-foot--6-inch-gauge line from Jos to Zaria. From the Egbe area tantalite is shipped by truck for a distance of some 50 miles to the railroad, probably at Offa, and thence by rail to Apapa. The railroads are single-track throughout, all locomotives are coal-fired, switches are manually operated, and train crews are native African. The efficiency of both crews and equipment is poor. Stations are protected by manual block signals on single or double wires. Repair shops are located in Zaria, Enugu, and Ebute. The Ebute shop near Apapa employs some 2,000 men. Lack of adequate passing facilities and shortages of locomotives, rolling stock, and spare parts are serious handicaps to efficient operation of the railway.

The track from Jos to Apapa crosses more than 100 streams. Three of them are crossed by railway bridges that also carry highway traffic -- the Zungeru bridge across the Kaduna River, 426 miles north of Apapa by rail, and the two bridges across the Niger at Jebba, 303 rail miles north of Apapa. On the line between Jos and Port Harcourt, there are 58 stream crossings, including several strategically important bridges. Bridges also cross the Mada River at points approximately 375 and 425 miles north of Port Harcourt.

Average running time between Jos and Apapa, 735 rail miles, is five days; that between Jos and Port Harcourt, 521 rail miles, is four days. The distance between Jos and Kano is 313 rail miles via Kaduna Junction and the Zungeru bridge across the Kaduna River and 221 miles via Zaria.

[redacted]

e. Highways.

The highway system of Nigeria is not adequate for a large volume of truck traffic. In the event of a railway failure, the highways could not be relied upon to take over the transport load. Although Jos is connected with both Lagos and Port Harcourt by all-weather roads, they are subject to washout during the May-October wet season. The 112-mile road between Lagos and Ibaden and the 50-mile stretch from Ibaden to Ife are paved. All other roads have earth or gravel surfaces. This includes the highway connections between Jos and Kano, a distance of 350 miles in the wet season which may in the November-April dry season by using secondary roads be cut to less than 200 miles.

Along the roads, culverts and small bridges are numerous, and bridges and ferries impose severe limitations on the speed and weight of vehicular traffic. At Jebba, 279 road miles north of Lagos, the main highway uses the two railway bridges for crossing the north and south channels of the Niger River. From 0630 to 1830 hours each day, these bridges are open to vehicular traffic between trains. The Nigerian Railway limits gross vehicular weight to 4,400 pounds, maximum tread width to 5 feet 6 inches, and maximum height to 18 feet. Twenty miles west of Bida and 385 road miles north of Lagos, through traffic crosses the Kaduna River by a ferry operated by the Nigerian Marine Department. Approaches to the ferry are covered with wire matting, and the ferry itself is a raft poled across the stream. Between Jos and Port Harcourt are two large bridges. The Benue River Bridge at Makurdi is a concrete rail-highway bridge with no weight limits but with a height limit of 16 feet. A highway bridge crosses the Ino River 15 miles northeast of Port Harcourt. There are no bridges across the lower Niger River. Ferries at Onitsha (Asaba) and Lokoja are operated by the Nigerian Marine Department.

f. Air Transport.

Neither columbite nor tantalite is currently being exported from Nigeria by air. The airport at Lagos is used regularly by

[redacted]

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the British Overseas Airways Corporation (BOAC) and by Air France. Koninklijke Luchtvaart Maatschappij (KLM) and Sabena have regularly scheduled flights from Kano North Airfield. During World War II, some ore was flown out of this airport, and the export, particularly of columbite from the Jos area, might again become practical.

g. River Transport.

During the dry season the Niger River is navigable for craft with draft of less than 6 feet as far north as Jebba, and the Benue River is navigable well above Makurdi. Most river craft draw 4 to 6 feet of water, and the barges range in capacity up to 300 tons.

h. Coal.

Coal for the Nigerian Railway and 13 thermoelectric plants, including the key installation at Lagos, is furnished by the government mine at Enugu, 180 road miles and 151 rail miles north of Port Harcourt. Seven thousand men are employed at the Enugu mine. Of the production, which averages between 600,000 and 700,000 tons of coal per year, 365,000 tons go to the Nigerian Railway. Reserves of coal are estimated at 17 to 20 million tons. In recent years, shortage of machinery and labor unrest have reduced production.

Equipment at the mine site includes: an air compressor, a step-down transformer, mine telephone system, air-circulating system, public address system, repair shops, mine railway of 2-foot gauge, cable for mine cars, and a conveyer belt. Water is supplied by the Enugu waterworks and electricity by the 3,400-kilowatt thermoelectric plant at Enugu. Coal is transported by rail to Port Harcourt, and from there by sea to Ijora coal wharf on Iddo Island at Lagos.

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i. Water Supply.

Waterworks serve the larger settlements, including Enugu, Jos, Lagos, Port Harcourt, and Kano. In the Egbe area, water is supplied by springs and streams.

j. Ports.

Nigeria is served by two major ports. Lagos will take vessels up to 27-foot draft and can handle 26 ships at one time; Port Harcourt will take six ships with drafts up to 23 feet. No other ports have rail connections.

Although Lagos is an island without rail facilities, it is connected to Iddo Island by the 1,800-foot Carter Bridge. Iddo Island, on which the 13,750-kilowatt coal-fired power plant is situated, is linked by rail and highway with the mainland over the 750-foot Denton Causeway.

Rail sidings at Apapa wharf on the mainland and at Ijora and Iddo wharves onEddo Island receive cargoes for inland destinations. Apapa has nine steel and concrete wharves varying in length from 160 feet to 1,800 feet, which are serviced by 11 electric cranes with capacities up to 25 tons; four steam cranes; and two floating cranes, in addition to a number of mobile cranes and lift buckets. Coal, oil, and diesel fuel are available at Apapa, and water may be taken on by pipe or tanker. Also available at this port are government slipways of 400-ton and 60-ton capacities, and a private slipway of 120-ton capacity.

At Port Harcourt there are only three mobile cranes of 3-ton capacity. Fuel oil, diesel fuel, water, and coal are available at the port. A bulk-storage oil plant is connected to tanker mooring buoys by pipelines.

Nigerian ports are now operating at full capacity, and rail and port facilities serving both Lagos and Port Harcourt are pressed to the limit under existing conditions. With an increase in port traffic, rail services would probably break down before port facilities.

5. The Manganese Industry in the Gold Coast.

a. General.

The manganese industry in the Gold Coast is compact and highly mechanized. Ore is mined near Tarkwa in southwestern Gold Coast, transported 39 miles by rail to the modern port of Takoradi, and loaded aboard ocean vessels.

b. Mining.

(1) Nsuta Area.

Practically the only producer of manganese ore in the Gold Coast is the African Manganese Co. Ltd., a British subsidiary of the American firm -- Union Carbon and Carbide Corporation. In 1946, head offices of the company were located at 19 St. Swithins Lane, London, E.C. 4.

The principal exploitation is an area approximately 1 by $2\frac{1}{2}$ miles in extent that runs in a north-northeast--south-southwest direction about a mile east of the town of Nsuta and the main Tarkwa-Takoradi railroad which runs through Nsuta. Tarkwa is a larger town located at latitude $5^{\circ}18'$N-longitude $1^{\circ}59'$W, 2 miles north-northwest of Nsuta. The mine is known as the Nsuta-Dagwin Manganese Concession and is reputed to be the largest single producer of manganese ore in the world.

Ore is removed from open cuts along the upper slopes of five hills by 1.5-cubic-yard Bucyrus steam and diesel shovels and is loaded into 5-ton steel dump cars. Cars are pulled to the treatment plant by diesel locomotives over a 2-foot--6-inch-gauge track. Overburden on the cuts averages about 1 cubic yard per cubic yard of ore. Proved reserves of ore amount to 10 million tons, but there are indications that the reserves exceed this figure.

About 10 percent of the crude ore is rejected in treatment. The ore is first washed in a plant with a capacity of 300 long tons per hour, which uses 2.5 tons of water per ton of ore. The waste

from this process is hauled to disposal dumps. The ore is then crushed and screened into three size groups:

(1) "Less than 1/4 inch," which is run to waste;
(2) "Plus 1/4 inch," which is sintered;
(3) "Over 1 inch," which is passed through a secondary crusher and screened to 2 inches. The remaining lumps are silicious pieces hand-picked from a moving belt.

The "plus 1/4 inch" is transported by narrow-gauge line (probably 2-foot--6-inch) to a plant alongside the main railroad a mile from the washing plant, where it is sintered. Fuel for sintering is anthracite duff from Wales. Sinter is conveyed by crane and aerial cableway to storage piles of 100,000-ton capacity, located at the railway siding. A poorly designed government-owned switchyard serves the 350,000-ton storage area at the mine.

Equipment in use at Nsuta in 1947 included:

Number	Item	Horsepower (Probably per unit)
5	Portable compressor	340
12	Rock drill	---
4	Water tube boiler	1,580
4	Vertical boiler	480
2	Rock crusher	425
2	Steam engine	1,040)
2	Oil engine	2,140) at power
2	Transformer	---) plant
2	Miles of transmission lines	---)
11	Surface pump	1,150
2	Winder, AC and DC	245
13	Excavator -- steam, diesel, and electric	1,680
28	Locomotive -- steam, diesel, and electric	3,010
1/4	Mile of ropeway	---

[redacted]

In 1948-49 the working force consisted of approximately 40 Europeans and 3,400 Africans. A large modern cafeteria seats 400 at a time and serves 3,000 meals per day.

During 1948-49 the company also worked its concession at Hotopo on the Sekondi-Axim road near the coast.

In order to increase production in the Nsuta area, additional equipment, including excavators, locomotives, etc., is being purchased in the US. All production not shipped with the US as a destination is shipped to the UK. France receives about 25,000 tons per year via the UK. It is estimated that 900,000 tons will be shipped in 1951, of which 600,000 tons will reach the US; the ferro-manganese will be manufactured in Norway or Canada. An estimated 75,000 tons of battery grade ore is included in the 600,000-ton figure. This estimated supply for 1951 to the US represents an increase of 100,000 to 150,000 tons over 1950.

The ore as shipped from the Nsuta area is mainly raw metallurgical grade plus some sinter, with a lesser amount shipped separately as battery grade material. The installation of the sintering plant has resulted in a 15-to-20-percent reduction in moisture contained in the shipped product, with a proportionate increase in ship capacity.

(2) <u>Other Manganese Areas.</u>

(a) The Aboaji and Ayehu deposits near Salmon (Esamang) in the Axim District, southwestern Gold Coast, are low in manganese and high in silica content. Both quality and quantity are too low for the ore to be marketable.

(b) Two small concessions located in an area 14 miles west of Takoradi, 4 miles northwest of Dixcove, and 1-1/4 miles from Asani in southwestern Gold Coast have been operated by the Yakau Manganese Co. Between 1941 and 1946 (when mining ceased) an estimated 9,000 tons were removed. Over half came from an open cut on the south slope of Himakron Hill, where the ore lies

[redacted]

in a bed 4 feet thick, located 26 feet below the surface. The ore was washed, bagged, and trucked 21 miles to Takoradi. Proved reserves amount to 30,000 tons.

(c) The Frary Manganese Co. Ltd., P.O. Box 25, Sekondi, is reported (February 1950) to have obtained manganese concessions and to have started operations at Dixcove, Yakau, and Salmon.

c. Transportation.

All the manganese ore from Nsuta is transported to Takoradi by rail. The ore is sent to Takoradi because it is the only deep water port of the Gold Coast.

The construction of roads in the Gold Coast has been minimized because they would compete with the government-owned railroad. There are 8,114 miles of roads, of which 636 miles are paved with tar, 2,078 miles are graveled, and the rest are unimproved, seasonal, dirt roads. Although trucking has increased in recent years because much of the railroad is only single track, any attempt to truck manganese ore in the quantity now carried by the railroad would require an enormous outlay for trucks, fuel, maintenance, and road repair. The road from Nsuta to Takoradi is graded and graveled; it is roughly 60 miles long, whereas the rail route is 39 miles.

Treated ore is reclaimed from stockpiles at Nsuta and loaded by diesel shovels onto gondolas of 25-ton capacity. Twenty or more cars make up a train, and five or six such trains run over the 39 miles of 3-foot--6-inch-gauge track to Takoradi each working day. Sidings and passing loops enable the traffic to move in both directions, which is necessary because of the large amounts of timber and cocoa that are also moved over this route.

The railroad, however, is unable to handle all the freight offered and has long been recognized as the principal bottleneck in Gold Coast manganese production. A plan for double-tracking

the railroad from Tarkwa to Takoradi has been approved and is in process of implementation. Rolling stock presents another problem. The 15 new locomotives received in mid-1949 were quickly placed in service, but those they were to replace had not been taken out of service as of May 1950. Coal was normally obtained from Nigeria until late 1949, when the supply was cut off, and cheaper and better coal is now obtained from Mozambique.

The railroad passes through an area of forest and steppe with an annual rainfall of 50 to 70 inches, except in the extreme south, where it drops to 35 inches. This dryer part near the coast has a population density of over 200 per square mile, whereas the density farther inland ranges from 25 to 50 per square mile, evenly distributed in small villages and clusters of homes, both on and away from the railroad. The railroad crosses several dozen small streams, most of them probably by conduit. The largest river, the Bonsa, is bridged at Esuaso, 28 miles from Sekondi.

Railway workshops and marshalling yards are located at Sekondi, five miles from Takoradi.

In January 1950 a strike of the railroad workers resulted in the dismissal of 722 employees.

d. Loading.

The coastal village of Takoradi was transformed in 1928-31 into a planned town, with the only deep water harbor in the Gold Coast. The 220-acre harbor is formed by an L-shaped main breakwater on the south and a straight lee breakwater to the north. The fairway between the two breakwaters is 600 feet wide. There are no cargo-handling facilities on the south breakwater. The main quay at the head of the harbor has a wharf for timber, lighter transit shed, and cocoa storage sheds. From the quay outward along the inside of the north breakwater are a coaling berth, tug jetty, manganese berth, two general cargo berths, and, near the seaward end, a bauxite loading berth. On the north side of the

north breakwater is a tanker berth. The railroad from Sekondi, 5 miles north, has several sidings that serve the whole length of the main quay and the three lines of track along the north breakwater that serve all but the bauxite berth.

In the curve of the south breakwater are six moorings with depths of 20 to 28 feet; west of them are three smaller moorings for coastal vessels. Along the western part of the south breakwater are lighter moorings.

Moored vessels can take on log rafts or handle small cargo lots by lighter; those in the manganese or general berths are also permitted to take on logs from the water side while loading from the dock side.

The cramped nature and general inadequacy of the harbor are due to its small size and number of facilities available for the increasing volume of traffic, rather than to obsolete machinery or cumbersome practices. The majority of ships using the harbor are not able to berth, and some are unable to anchor inside the harbor. Manganese ships have at times been forced to wait for weeks until the single loading berth was free.

A £2,250,000 contract for enlargement and alteration of the harbor was signed in 1949, presumably with Taylor Woodrow Construction, Ltd. Work was begun sometime during the last seven months of 1950 and was scheduled for completion in 1951 but is at least a year behind schedule. Furthermore, officials of the construction company estimate that the harbor as now planned would be inadequate or would relieve congestion for only a few years. The plan calls for moving the bauxite berth to the north side of the north breakwater (outside the harbor) and adding two more berths on the south side of the north breakwater near its seaward end. Railway facilities and the quay approach are to be enlarged and timber wharves built. No plans are reported for changing manganese-loading facilities.

Manganese tonnage available for loading is controlled by rail shipments from the mine, which range from 2,000 to 3,000 tons per day and average 16,000 tons per week. Since the ore is sent to Takoradi as it is produced (as of October 1950), there is probably very little in storage at the mine. A storage area near Takoradi station can hold 80,000 tons, and one at the manganese berth 18,000 tons.

The manganese loading operation is entirely mechanical. The 25-ton ore gondolas made up at the mine are emptied at the larger storage area or are shunted onto the wharf. Here the cars run through a tippler, where they are emptied one at a time into a hopper. The hopper empties onto an apron feeder which may discharge onto the wharf stockpile or deliver the ore to a conveyer system where it is weighed and carried by shuttle to a loading bridge. The loading bridge is on a gantry that runs the length of the manganese berth, thus enabling it to load any hold of a ship. Ore can be reclaimed from the wharf stockpile by two steam shovels that run on tracks and empty into the loader. If ore is to be reclaimed from the larger storage area, it must again be mechanically shoveled into the 25-ton cars, which are then shunted onto the wharf and tippler.

Speed of loading is by no means up to the capacity of some of the facilities. The loader, for example, can deliver 1,000 tons per hour, but more than 3,000 tons are seldom loaded per day, because only that much can be brought in by rail. Inefficiency on the part of local cargo trimmers also keeps the loading rate down to about 200 tons per hour. Vessels may load to a draft of 28 feet 6 inches, but if so loaded, they can move out only at high water, since the minimum channel depth at low water is 25 feet . In addition, a heavy surge is reported in the manganese and general cargo berths.

The Oil Storage Company of Takoradi has an oil pool that is a joint venture by the Shell, Socony Vacuum, Texas, and Atlantic Oil Companies, and is operated by Socony. The pool is located $2\frac{1}{2}$ miles north of Takoradi and is connected with the fuel berth on the north side of the north breakwater by three pipelines.